Lower Passaic River Interim Remedy Feasibility Study
Summary of Projection Modeling Approach
February 28, 2019

Model projections will be performed using the LPR RI/FS hydrodynamic (HD), sediment transport (ST), organic carbon (OC) and contaminant fate and transport (CFT) models to evaluate future condition under the Monitored Natural Recovery (MNR) alternative (no action) and four active remedial alternatives defined by their post-remedy 2,3,7,8-TCDD SWAC targets: 125 ppt, 85 ppt, 75 ppt and 65 ppt. The contaminants of concern to be evaluated are 2,3,7,8-TCDD and tetra-CB (which is used as a surrogate for total PCBs). Details of the proposed projection modeling approach are provided below.

Simulation of Future Conditions

All alternatives (including the MNR alternative) will represent the ROD remedy in the lower 8 miles of the LPR. Projection simulations will begin with the first year of the ROD remedy and run through 10 years post-remedy after the longest IR alternative. The WY 1996 to WY 2010 hydrograph will be cycled as needed to achieve this run length. The initial conditions (ICs) for these simulations will be set as follows:

- The predicted bathymetry at the end of the HD/ST model calibration period (WY 1996 to WY 2013), which includes the post 50-ft deepening bathymetry in Newark Bay and the Kills, will define the initial bathymetry for the projection runs. Specifically, it will be used to initialize the ST model spin-up run described below.
- The ST model initial bed properties (i.e., bed composition and bulk density) and water column suspended sediment concentrations will be based on a one-year spin-up run performed with the WY 1995 hydrograph and the bed properties at the beginning of the WY 1996 to WY 2013 ST model calibration run. One exception is the bed properties for any grid cells that are remediated during the calibration simulation will use the properties from the end of the ST calibration. This could include the two grid cells associated with the Tierra Phase 1 removal, and may also include the capped cells from RM 10.9 removal in the sensitivity runs (see further discussion in the sensitivity simulation section).
- The OC model initial carbon concentrations will be specified in a manner similar to the WY 1996 to WY 2013 calibration period, i.e., the predicted cohesive sediment fraction in the bed at the end of the spin-up ST model run will be combined with the data-based relationship between fraction organic carbon (foc) and cohesive fraction developed in RI Appendix N.
- The CFT model initial sediment contaminant concentrations will be based on the "2010" mapping (see RI Appendix J), which combines conditional simulation results in the surface sediments (0 to 0.5 ft interval) with a resampling method in the 0.5 to 1.5 ft interval and Thiessen polygons beneath that. The MNR base run will use Conditional Simulation (CS) 37

results in the surface sediments with the exception of the RM 10.9 removal area, which will be assigned an average concentration based on the post-remedy monitoring data[1].

The projection boundary conditions (BCs) will be set as follows:

- Hydrodynamic model BCs (flows, open boundary elevations in the Kills, salinity, temperature, wind stress, and heat flux) will be repeated from the calibration period in accordance with the cycling of the WY 1996 to WY 2010 hydrograph (i.e., BCs for WY 1996 are used for projection years 1 and 16).
- Solids, carbon (detrital and algal), and contaminant loads from the Dundee Dam, tributaries to the LPR, the Hackensack River, point and nonpoint sources (CSOs/SWOs, WWTPs), and atmospheric loadings (contaminants only) will also be the same as for the corresponding calibration hydrograph years.
- For the Kills, the solids boundary concentration will be based (as in the calibration) on the predicted flow at the boundaries paired with a solids loading relationship under the post-50 ft deepening bathymetry in NBSA and the Kills (see Appendix M), and the carbon and contaminant concentrations will be based on the output from continuous simulations of the regional EPA Contaminant Assessment and Reduction Program (CARP) model. Specifically, the EPA FFS model projection BC sequence starting in WY 2014 will be used for the carbon concentration (this year coincided with the WY 1996 hydrograph in the FFS model inputs). For contaminant concentrations, the EPA FFS model projection BC sequence starting in WY 2021 will be used to reflect the concentration reduction predicted by the CARP model[2]. Furthermore, tetra-CB concentrations from the Kills boundary will be reduced by half to be consistent with the boundary settings in the CFT model calibration (see RI Appendix O).

During the projection run, the bathymetry in the HD/ST models in the active Newark Bay, Arthur Kill, and Kill van Kull navigational channels will be reset to the 50 ft design depth every five years (starting from the end of projection year 5) to represent maintenance dredging.

Simulation of Active Remediation

The remedial footprints and volumes for each alternative will be mapped to the model grid, and the dredge sequence and duration of each model grid cell will be determined based on the assumed production rate. The base projection runs will use remedial footprints based on CS 37 sediment initial conditions (i.e., the same CS used in the base MNR run).

For the lower 8 miles of LPR, the ROD remedy for all alternatives will be simulated in a manner similar to EPA's FFS modeling. The EPA dredge sequence will be used, with the start year shifted to coincide with the WY1996 hydrograph (rather than the WY2002 hydrograph used in the FFS). The bed elevations in the HD model will be updated daily in remediated cells to gradually impose the bathymetric change resulting from dredging (dredging followed by capping back to grade, except for in the navigational

[1] For 2,3,7,8-TCDD, a mean value of 227 ng/kg will be applied based on the 16 available 2015 ERT and 2016 CPG post-remedy cap monitoring data points. For tetra-CB, a mean value of 0.15 mg/kg will be applied based on the 2015 ERT data only (6 samples), because the CPG dataset did not report tetra-CB.

[2] Year 2021 is the assumed start year of the ROD remedy in the lower 8 miles based on past EPA direction.

channel in the lower 2 miles where the LPR is deepened in conjunction with the remedy). The sediment composition and bed foc in remediated cells will be adjusted to reflect the cap material in the ST and OC models, respectively, and the contaminant concentrations for the CFT model bed (active and archive layers) in remediated areas will be set to zero. An assumed dredge resuspension loss rate of 3% will be applied to release sediment, carbon, and contaminant mass to the water column, distributed equally between the top and bottom layers of the water column.

The remedy representation for the upper 9 miles IR requires a modified approach because the IR targets are typically smaller than the model grid cells (unlike the bank-to-bank ROD remedy in the lower 8 miles). For the base set of projection runs, IR remediation will be represented in the CFT model but not in the HD, ST, and OC models; rather the CFT runs will use MNR HD/ST/OC model results. CFT model bed concentrations for a given cell will at the time of remediation be multiplied by an input reduction factor that reflects the ratio of the grid cell average pre-dredge concentration in the 2010 mapping to the grid cell average post-dredge concentration after the concentrations in targeted areas have been reset to zero[3]. The reduction factors[4] are COPC-specific and will be computed for each data layer considered in the mapping, i.e., 0 to 0.5 ft, 0.5 to 1.5 ft, 1.5 to 2.5 ft, 2.5 to 3.5 ft, and 3.5 to 5.5 ft[5] based on the typical sediment core segmentation. Consistent with the ROD remedy representation in the lower 8 miles, 3% of the contaminant mass removed will be released to the water column at the time of dredging and will be equally distributed to the top and bottom water column grid layers.

The impact of partial cell remediation on sediment transport is not represented because the nonlinear relationship between grain size and sediment erodibility precludes accurate representation of reduced sediment erodibility in cells that are partially capped. The release of solids to the water column associated with dredge resuspension will also not be included in the base runs for consistency with not representing capping. Likewise, the influence of water column carbon release and bed carbon adjustments due to capping are ignored in the OC model base runs for consistency with the ST model treatment. The influence of representing these processes in the projections will instead be assessed via sensitivity runs on one alternative, as described in the next section.

Sensitivity Simulations to Characterize Projection Uncertainty Due to Mapping Uncertainty and the Inability to Accurately Represent Capping

Additional simulations will be performed to assess the model uncertainties associated with sediment contaminant mapping and the representation of remediation in the ST and OC models. These

[3] Although the underlying footprints will be developed by assuming a 10 ng/kg residual concentration of 2,3,7,8-TCDD when conducting the hill-topping to achieve a given alternative's target SWAC, a zero residual concentration is assumed in calculating the concentration reduction factors. This is done because the model explicitly accounts for recontamination due to resuspension during the dredging and other contaminant sources.

[4] This is equivalent to assigning a weighted average of zero concentration in the remediated portion and the mapped concentration in the unremediated portion, adjusted by the predicted fractional change of the grid cell concentration from its IC to the time of remediation, as discussed in past EPA/CPG modeling meetings.

[5] Sediment contaminant concentrations below 2.5 ft will also be adjusted to reflect the remedial footprint despite these intervals being below the anticipated dredge depth. The base model does not account for the sequestering of this contaminant by the cap and if left unadjusted, it could corrupt the projection by impacting the surface sediment concentrations.

simulations will be performed for the 75 ppt post-remedy SWAC alternative, and the results will be used to define an uncertainty band that will be applied to all alternatives.

The contaminant mapping uncertainty will be assessed by running simulations with sediment initial conditions based on two alternate CS maps. The maps selected for this purpose are CS 57 and CS 81, which are expected to yield higher recovery and lower recovery during the IR, respectively, based on CPG and EPA evaluations of the covariance of the concentration field with erosion and deposition patterns. Remediation footprints for the 75 ppt post-remedy SWAC alternative will be delineated for each of these recovery bounding maps, and the simulations will be performed using the same approach as the CS 37 base runs.

The uncertainty associated with IR representation in the HD, ST and OC models will be assessed by performing simulations in which the IR remediation is explicitly represented in these models. For each of the remedial footprints of the 75 ppt post-remedy TCDD SWAC alternative evaluated in the base runs (using CS 37) and the mapping uncertainty sensitivity runs (using CS 57 and 81), "scenario-specific" HD, ST, and OC model runs will be performed and propagated through the CFT model, using the same modeling approach as in the base projections. These runs will represent the temporary bathymetric adjustments due to dredging and subsequent capping, the release of solids and organic carbon to the water column during dredging, and changes to the surface sediment bed properties caused by capping. Due to the previously noted limitations of representing sub-grid scale capping, only cells with more than 50% remediated area will be capped in the ST and OC models (the dredging-associated solids and carbon release to the water column will be simulated for all cells with remediation, as grid scale limitations do not prevent the representation of this process).

Note that RM 10.9 removal in 2013 is considered a partial cell remediation similar to the IR remediation. For consistency, dredging and capping will not be represented in the RM 10.9 removal area in the MNR and mapping sensitivity simulations, and the 50% area rule will be extended to the RM 10.9 removal area for the capping representation sensitivity simulations.

Summary of FS Model Projection Simulations

A total of 4 runs for the HD/ST models, 4 runs for the OC model, and 20 runs for the CFT model (10 each for 2,3,7,8-TCDD and tetra-CB) will be performed for the FS under the approach described above, as summarized in Table 1.

Table 1. Summary of Planned FS Projection Simulations

Projection Number	Category	CS Map	CFT Model Inputs*	HD/ST Model Inputs*	OC Model Inputs*
1	Base Projection	CS 37	MNR	MNR	MNR
2			85 ppt		
3			75 ppt		
4			65 ppt		
5			125 ppt		
6	Mapping Uncertainty	CS 57	75 ppt	MNR	MNR
7		CS 81	75 ppt		
8	HD/ST/OC Representation Uncertainty	CS 37	75 ppt	75 ppt	75 ppt
9		CS 57	75 ppt	75 ppt	75 ppt
10		CS 81	75 ppt	75 ppt	75 ppt

*Column entries refer to the remedial alternative that is the basis for the inputs, where concentrations refer to the 2,3,7,8-TCDD post-remedy SWAC target that defines the active alternatives.